

Title: "Method and Apparatus for Proper Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079 2/18 Figure 1(e) - detail of field point a 21 x 21 array of outer frame structures the near circular region is near a 15  $\times$  15  $\,$ 550 um alignment attributes - however, structures ~400um in diameter Each field point contains array of frame-in-frame Field point number at wafer level Wafer Notch One Exposure ready for overlay Exposure field measurement embodiment of preferred

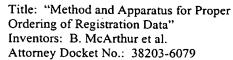
Figure 1(d) Preferred embodiment - typical wafer level exposure pattern

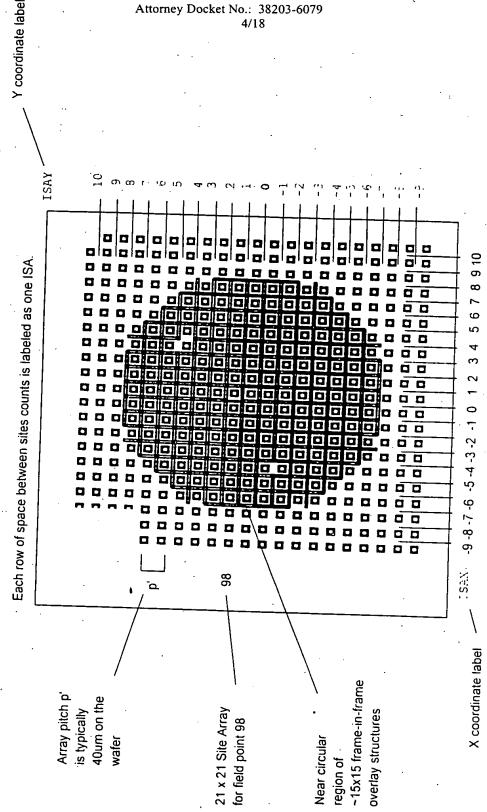
Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079 3/18 Figure 2(a) Prior Art Printed ISI reticle image (two exposures) from U.S. Patent 5,978,085 – one field point Grid MA - from first exposure Box MX - from second exposure p' = pitch of the frame-in-frame overlay targets is 40um at the wafer is 10um x 10um at the wafer Inner frame structure Figure 2(b) close up view of alignment attribute REFERENCE One of many field points 15<sub>um</sub>

15<sub>um</sub> outer frame at the

Title: "Method and Apparatus for Proper

Figure 3 Diagram of ISA coordinates for a given field point

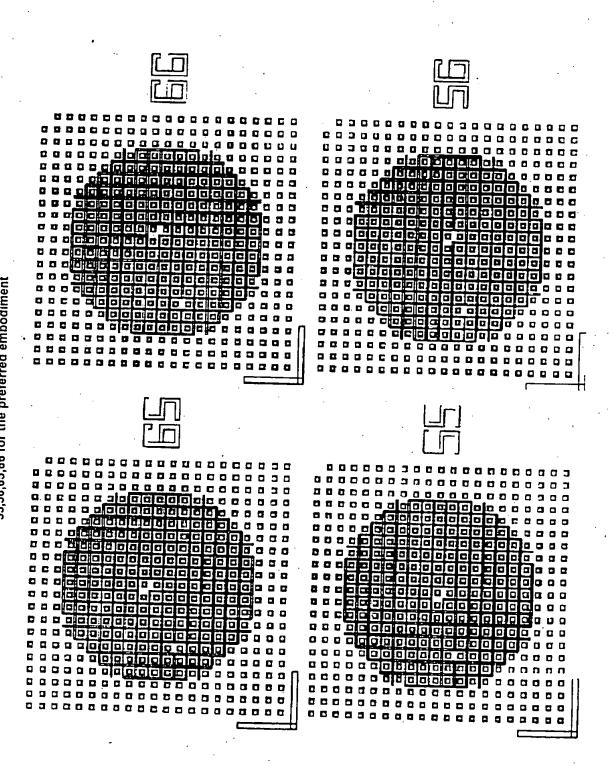




Title: "Method and Apparatus for Proper

Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079

5/18



Title: "Method and Apparatus for Proper Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079 6/18

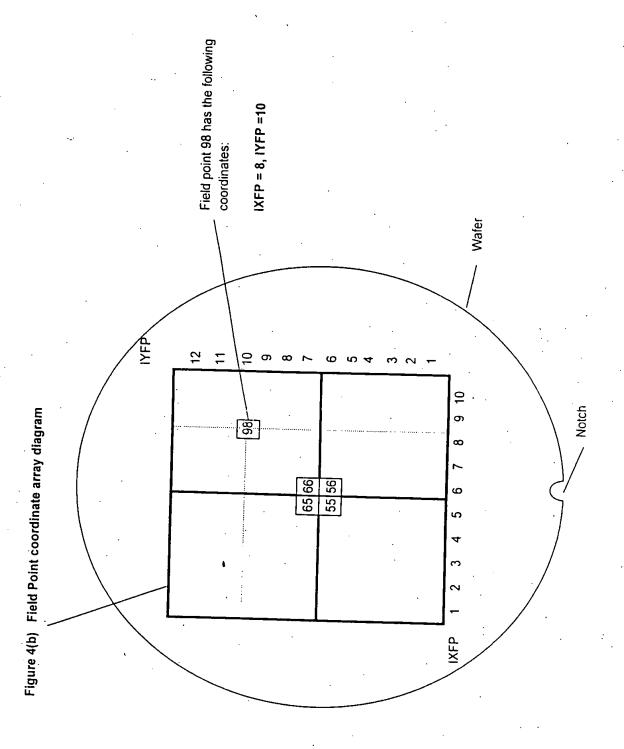
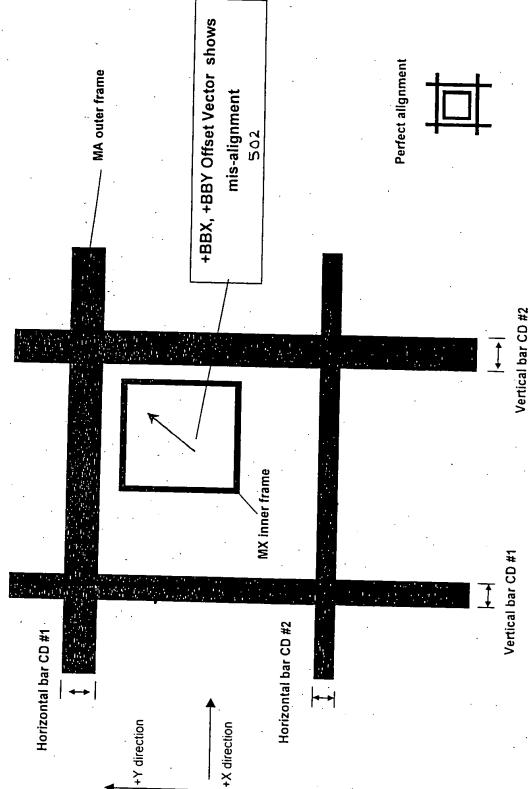


Figure 5(a) Sign convention for BBX and BBY offsets and fourth encoding scheme at wafer level

The small inner frame is shown mis-aligned to the larger outer frame this produces

an x-shift and y-shift overlay positional offset (+BBX and +BBY)

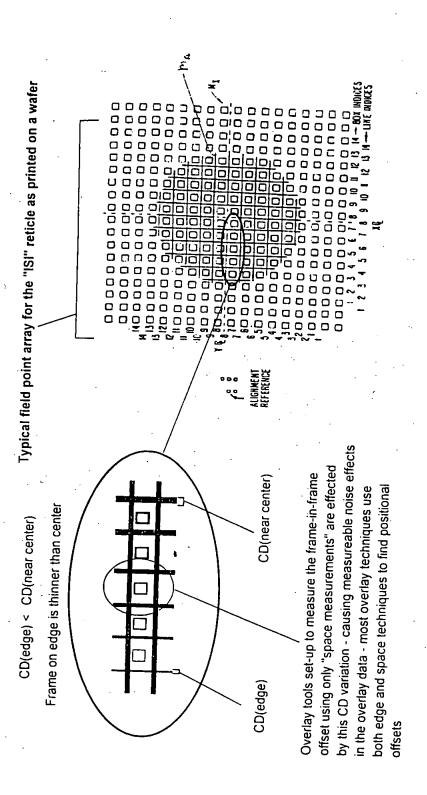


Prior Art.

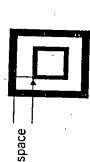
Title: "Method and Apparatus for Proper

Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079

Figure 5(b) Typical Overlay errors



Overlay measurements using CD or edge techniques



Overlay measurements using space techniques



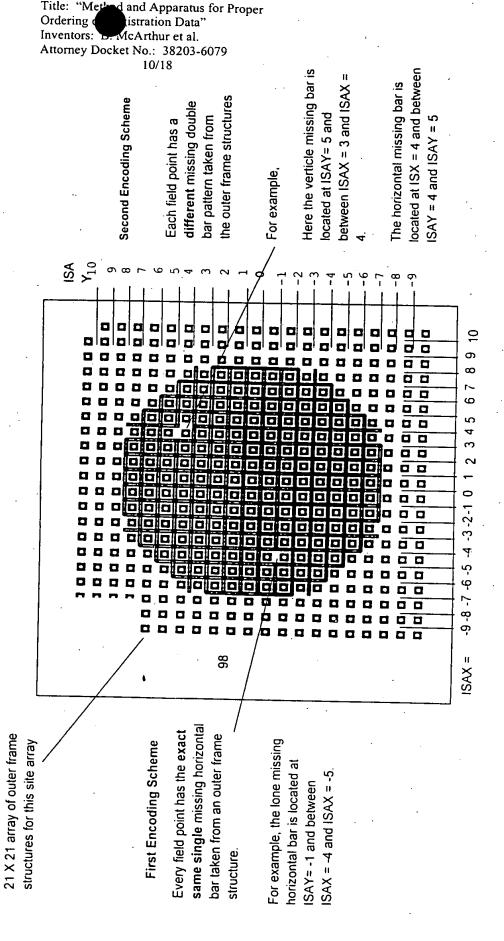
Title: "Method and Apparatus for Proper Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079 9/18

Figure 5d, Bar in box or frame in box measurement producing non zero offset in presence of CD variation (CDL > CDR).

- Offset > 0

Figure 5c, Bar in bar or frame in frame measurement producing 0 offset in presence of CD variation (CDL > CDR).

Figure 6 First two encoding schemes - missing-bar layout for field point 98



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Title: "Method and Apparatus for Proper Ordering of Registration D Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079 12/18

Figure 8 location of (0,0) point of frame-in-frame data on setup-reticle

= position within 21 x 21 array where (BBx,BBy) = (0,0) occurs

IXO IYO FP

≖ field point number

IV=	Paw
11=	ROW

1 = ROW										
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8	13	13	13	13	13	12	13	14	15	16
	71	72	73	74	75	13	13	13	13	13
	7	8	9	10	11	76	77	78	79	80
7	12	12	12	12	12	12	13	14	15	11
	61	62	63	64	65	12	12	1.2	1.2	1.2
	7	8	9	10		66	67	68	65	747
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IX=Col

or completed alignment attributes Figure 9 Typical overlay patterns

− box-in-box 902

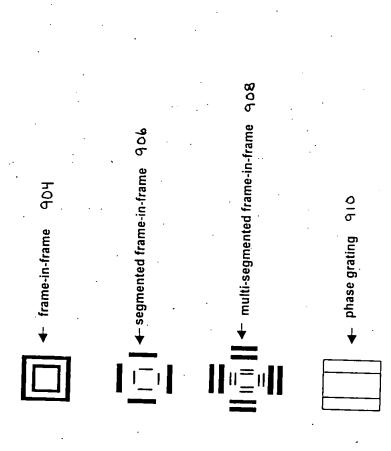
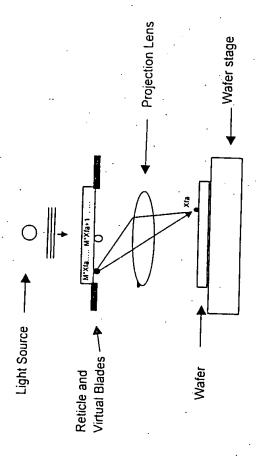
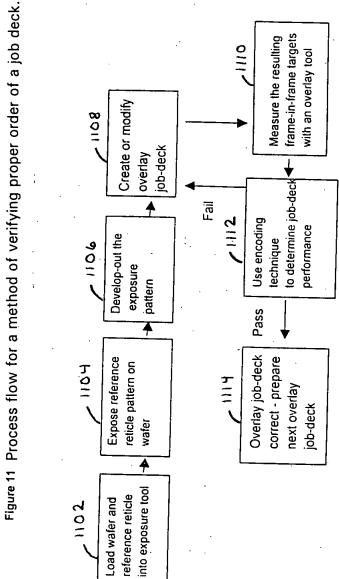


Figure 10 Photolithographic stepper or scanner system

Title: "Method and Apparatus for Prope Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079 14/18

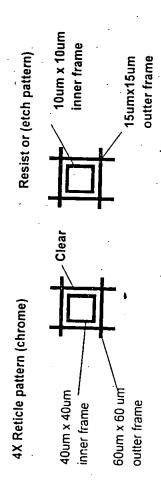


Title: "Method and Apparatus for Proper Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079 15/18



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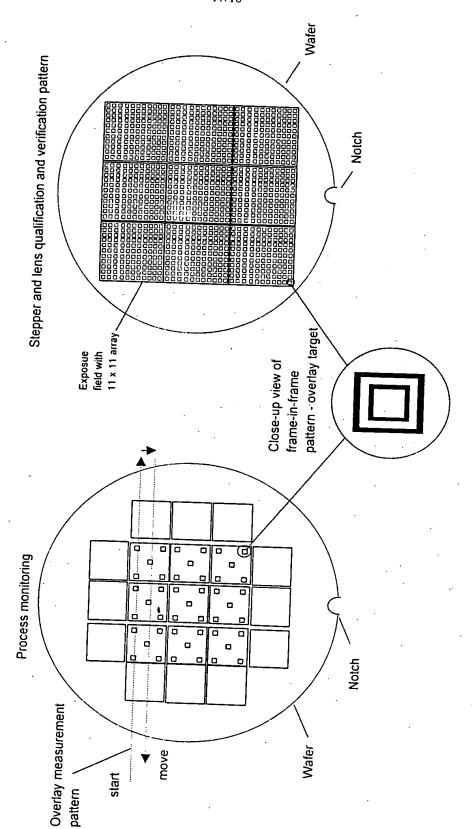
Figure 12 Reticle and resist frame-in-frame description for a typical ISA coordinate site ISAX, ISAY



No shift: ISAX = 0, ISAY =0 Frame-in-Frame structure Figure 13 Centered



Figure 14 Prior art - exposure patterns: Process monitoring and Stepper qualification



Prior Art

Figure 15(a) Process flow for prior art - Photolithographic tool set-up

reticle

Title: "Method and Apparatus for Proper Ordering of Registration Data" Inventors: B. McArthur et al. Attorney Docket No.: 38203-6079

18/18

projection lens aberrations Calculate process alignment Verify and correct overlay program determine the frame-in-frame targets Measure the resulting pool all available data performance with an overlay tool -Statistically Perform overlay measurements overlay job-deck Perform overlay measurements Create Figure 15(c) Process flow for prior art - lens abberation measurement Remove invalid overlay data Figure 15(b) Process flow for prior art - Production use of overlay Develop-out the Pull 3 wafers from production lot Program overlay tool to measure overlay targets exposure sampling for overlay pattern random components of Statistically determine 4 the systematic and intra-field error Expose reticle inter-field and Develop resist pattern on Develop resist wafer patterns patterns into exposure tool Load wafer and

production wafers Align and expose

into the exposure

nachine

and ISI reticle

Load wafer

corrections to the

exposure machine

Apply overlay